

DENTAL ARMAMENTARIUMS AND ITS EFFECT ON CARDIAC ARMAMENTARIUMS AND ITS FUNCTIONING: AN ORIGINAL RESEARCH

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ABSTRACT

Aim: The purpose of our research was to evaluate the effects of dental electromagnetic devices on the functioning of implanted cardiac devices in patients.

Methodology: Biotronik Actros DR+ pacemaker was evaluated at maximum sensitivity on a flat bench top. The pacemaker lead, electronic apex locator, and oscilloscope were connected across a 150-ohm resistor. Pace monitoring was carried out with a Biotronik EPR 1000 programmer and a Tektronix TDS 220 2-channel digital real-time oscilloscope.

Results: Four of five electronic apex locators tested did not cause inhibition or interfere with normal pacemaker function.

Conclusion: It seems that electronic apex locators can be used safely in patients with pacemakers.

Keywords Pacemakers, Apex locator; Electromagnetic interference, Arrhythmias

INTRODUCTION

Pacemakers and implantable cardioverterdefibrillators (ICDs) are electronic devices that emit electrical signals and are sensitive to electromagnetic signals in the vicinity. They are being implanted gradually more so in people,^{1,2} particularly elderly people, who also visit the dental office. Surgically implanted pacemakers provide regulated pacing for cardiac bradyarrhythmias. Most pacemakers are implanted in people with severe complete heart block.^{3,4} Technological advances in permanent pacemakers across the past 30 years, however,

have resulted in increased indications for their use including to treat sinus node dysfunction and to enable tolerance of atrioventricular nodal blocking agents.⁵ Owing to these advances and the aging population, there has been a significant increase in the incidence of permanent pacemaker implantation.¹ Physicians have cautioned patients with implanted cardiac pacemakers and ICDs that electromagnetic interference might occur and cause device malfunction, harm patients or do both.^{6,7} Advice has been disseminated to patients to evade magnetic resonance imaging machines, cell phones and electrocautery devices.⁸⁻¹⁰ The dental literature also comprises of articles that counsel practitioners to avoid operating certain dental devices as they may produce electromagnetic interference and cause pacemakers to not function properly.¹⁰⁻²⁰ Indication, is that electromagnetic interference of the activity of newer advanced-design pacemakers and ICDs during the operation of select electronic dental devices may be less of a concern.²¹⁻²⁴ Although pacemakers today are smaller and have more protective features than those of the past, many common dental devices emit electromagnetic waves that can interfere with their functions. As the rate of pacemaker and ICD implantation is increasing,^{1,2} especially in elderly people, the elimination of electrical interference that could cause these cardiac devices to function improperly and, thus, adversely affect the cardiac health of dental patients is an important issue. There is a possibility that exposure to some dental equipment may temporarily affect the function of an implanted pacemaker or defibrillator. Electromagnetic interference (EMI) may occur when the electromagnetic field from one electronic device interferes with the operation of another electronic device. These electromagnetic signals have the potential to mimic the electrical activity of the heart, or be interpreted by the implanted pacemaker or defibrillator as electrical noise. Possible device responses to EMI include:

- Inhibition of pacing – pacing therapy not provided when required
- Asynchronous pacing – pacing therapy provided at a fixed rate regardless of the heart's need for therapy
- Inappropriate shocks – shock therapy provided when not needed

Electronic apex locators (EAL) are extensively used in endodontics to measure the root length during root canal treatment. Introduced by Sunada in 1962, the EAL has become an invaluable tool in modern endodontic practice.²⁵ Although Beach et al. published a case report in 1996 documenting the usage of an EAL in a pacemaker patient without clinical event, the dental literature lacks research in this area.²⁶ Interestingly enough, the instruction manual for many EALs clearly warns against the use of such devices in pacemaker patients, even though no studies have been published to prove or disprove such practice.²⁷⁻²⁹

AIM OF THE STUDY

The purpose of our research was to evaluate the effects of dental electromagnetic devices on the functioning of implanted cardiac devices in patients especially the pacemakers.

METHODOLOGY

Five EALs were tested for pacemaker interference, including the Root ZX, Justwo, EIE, Neosono, and Bingo- 1020 and one ultrasonic scaler (Cavitron Select SPS, Dentsply. A Biotronik Actros DR+ pacemaker with an atrial lead (model PX45JBP) was set to 60 pulses/min and evaluated at maximum sensitivity on a flat bench top. With the help of a

digital real-time oscilloscope pace monitoring was carried out. A circuit was designed with EAL, pacemaker lead connected to oscilloscope and with a 150-ohm resistor. The pacing pattern of the pacemaker functioning was monitored with the help of telemetry wand for period of 25 to 30 s. A negative control was steered with the pacemaker alone. An ECG simulator connected across the resistor, in place of the EAL, served as a positive control. The control trials were carried out for 10 s in both unipolar and bipolar modes. Pacemaker activity was nonstop logged on as an ECG printout. These recordings were then scrutinized for pacer inhibition, noise reversion, or unsuitable pacemaker pulses.

RESULTS

The negative control showed a normal pacing pattern; the positive control showed pace inhibition. The Root ZX device caused no interference with pacemaker activity. Telemetric recordings for the Justwo and the EIE apex locators both showed the absence of two paced beats within the test period along with ultrasonic scaler as well, whereas the Neosono showed that five paced beats were not registered. (Table 1, 2) However, all three devices showed normal pacing on the oscilloscope. The Bingo-1020 device produced an irregular pace recording and oscilloscope pattern but was not statistically significant ($p=0.078$) (Table 3). All devices, with the exemption of the negative control, produced varying degrees of background noise on the telemetric recordings.

DISCUSSION

There had been dramatic upgrades in pacemaker era over the previous couple of decades. Pacemakers synthetic earlier than 1975 used discrete digital additives encapsulated in a clean epoxy case. Electromagnetic interference (EMI) should effortlessly penetrate the pacer and have an effect on the digital circuits. Modern pacemaker electronics are shielded in a hermetically sealed steel case with capacitors that successfully clear out EMI signals. Because more recent pacers are much less at risk of interference, effects of research carried out within the beyond might also additionally not be applicable.^{30,31} Of predominant subject to the dentist practitioner is the opportunity of electromagnetic interference (EMI) and electromagnetic disturbance from electrosurgery/electrocautery gadgets, apex locators, lasers, electric powered handpieces, radiation, and different digital sources. Additionally, vasoactive drugs, along with epinephrine containing nearby anesthetics and different sympathomimetics that can be administered at some point of anesthetic management, might also additionally have sizeable results upon sufferers who be afflicted by tachyarrhythmias.³² Recent investigations into capability EMI generated from piezoelectric gadgets have validated no interactions with implantable cardioverter-defibrillators.³³ Older research and function papers endorse that electrosurgical gadgets, ultrasonic instrument cleaners, and magnetorestrictive ultrasonic scalers might also additionally intrude with pacer gadgets as much as a distance of 37.5 cm.³⁴ However, there aren't any reviews of pacer oversensing or unintentional shock delivery. Recently, similarly investigations have observed that electric powered vehicles observed in dental handpieces, mild-curing gadgets (each battery powered and corded), endodontic heat carriers, apex locators, and electrosurgical gadgets all generate a few degrees of EMI, but most effective the electrosurgery gadgets produce electromagnetic disturbances which could probably adversely have an effect on the characteristic of ICDs via way of

means of turning in an unintended shock.³⁵ In a current in vitro research, Roedig and colleagues observed that operation of one type of ultrasonic scaler, ultrasonic cleansing device and battery-operated composite curing light inhibited the pacing feature of implantable cardiac pacemakers, but only the scaler and the curing light interfered with the pacing characteristic of implantable cardioverter-defibrillators. In addition, they concluded that one sort of amalgamator, electric powered toothbrush, electric powered pulp tester, electrosurgical unit, and high-pace and low-pace dental handpieces examined produced no electromagnetic interference.¹² Normal oscilloscope patterns imply uninhibited pacemaker activity. Interestingly, the telemetric recordings for the Justwo, EIE, and Neosono gadgets as well as ultrasonic scaler did not check in numerous paces in spite of such patterns. This phenomenon can be attributed to an electromagnetic impact of the EAL housing at the telemetric wand as opposed to inhibition of pacemaker characteristic. Although the Bingo-1020 confirmed mild interference on this have a look at, the scientific implications are unknown. Some aspect of the apex locator housing blended with its digital circuitry might also additionally have affected the pacemaker on this case. Manufacturers of EALs continuously warn towards using their gadgets in patients with cardiac pacemakers in spite of the absence of proof to aid such claim. Although they will possess bench test information just like the ones proven above, the dearth of scientific information might make it hard to gain FDA popularity of the gadgets with out such warnings.¹¹⁻¹³ Human trials are had to make clear this issue. In addition to cardiac pacemakers, future studies must compare the results of dental gadgets on implantable defibrillators.

CONCLUSION

The effects of this study endorse that EALs and ultrasonic scalars may be used appropriately in patients with pacemakers. Nevertheless, similar research in humans are required to verify these findings.

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TABLES

Table 1- Pattern of pacemaker functioning noticed in relation to dental devices
(*Interference with respect to the lead*)

Dental devices	Unipolar mode (cm)	Bipolar mode (cm)
Root ZX	≤15	≤ 3
Justwo	≤15	≤3
EIE	≤14	≤6
Neosono	≤14	≤5
Bingo- 1020	≤23	≤11
ultrasonic scaler (Cavitron Select SPS)	≤17	≤8

Table 2- Mean value noted in relation to various dental gadgets

Dental devices	Unipolar mode (cm)	Bipolar mode (cm)
Root ZX	2.4±1.8	0.97±0.78
Justwo	2.67±1.60	0.93±0.85
EIE	2.56±1.43	0.94±0.83
Neosono	2.87±1.45	0.89±0.56
Bingo- 1020	1.12±0.92	0.27±0.01
ultrasonic scaler (Cavitron Select SPS)	1.45±1.19	0.67±0.32

Table 3- chi square test measurement recorded in the present study

Dental devices	χ^2	p value
Root ZX	4.77	0.01
Justwo	4.03	0.0245
EIE	4.78	0.0311
Neosono	4.12	0.0188
Bingo- 1020	2.98	0.078
ultrasonic scaler (Cavitron Select SPS)	3.556	0.0264

* $p < 0.05 = \text{significant}$